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BY

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SOME HAZARDS OF TRANSPORTING EXPLOSIVES IN AUTOMOBILE TRUCKS[1]

By C. W. Owings[2] and J. M. Harrington[3]

The transportation of explosives, and especially their distribution from the supply magazines of the manufacturers or dealers to the mines, quarries, or other points where they are to be used, by means of horse-drawn vehicles is an old-time practice, and the records of accidents of the past show this to have been a hazardous undertaking requiring for safety the taking of many precautions not required in the transportation of other merchandise.

Displacement of the horse-drawn vehicle by the motor vehicle for the transportation of explosives is increasing rapidly. A consideration of the facts that the vehicle is operated by an explosion engine, using easily vaporized liquid fuel; that the charges in the engine are fired and the vehicle lighted by electricity; and that the vehicle, being operated insulated from the ground, may accumulate static charges led to the conclusion that new hazards are being introduced into the transportation of explosives through the use of motor-operated vehicles, and that therefore additional special precautions must be taken against these additional hazards.

That accidents have already occurred in this use of motor-vehicle transportation is evidenced from the following examples:

Recently in California a driver loaded a box of granular powder in the rear of an automobile truck and a box of electric detonators in the front. Suddenly, while traveling along a highway, the explosives detonated, demolished the truck, and blew the body of the driver into small pieces. No evidence was left to show the cause of the explosion, but it is assumed that a jar or other means caused the detonators to fire, and that they in turn detonated the explosive It should be recognized that it is unsafe to transport detonators and explosives in the same compartment, and this rule should be strictly enforced. At present this rule appears to be either unknown or, at least, frequently ignored.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6330."

2 Associate engineer, U. S. Bureau of Mines.

3 Senior foreman miner, U. S. Bureau of Mines.

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There are usually so many possible causes of ignition or detonation of a truck load of explosives that it is often impossible to state definitely the exact cause in a given case. This is well illustrated in the following account of an accident: A trucking company was hired to haul a truck load of explosives about 200 miles. The driver had had experience in driving trucks of explosives, and it was stated that he inspected the truck carefully before leaving the garage. Eighty 50-pound boxes of explosive were placed in tiers on each side of the truck and 265 25-pound kegs of black blasting powder were placed in the center of the truck. The boxes were placed flat and the kegs were placed on end, arranged in tiers. While the truck was being driven along the highway there was a muffled explosion. When some men, who were about a quarter of a mile away, arrived at the scene the truck was in flames and they could get no nearer than 100 feet. The driver was sitting in his seat and had apparently been killed instantly either by shock or fumes. When the flames were finally quenched, the driver's body was recovered, badly charred. It was found that several boxes of explosives had been thrown about 40 feet by the initial explosion but were uninjured. A total of half a ton of dynamite was recovered. The cover to the gasoline tank could not be found.

A number of unsafe conditions were discovered. Metal was exposed on the inside of the truck, thereby providing a means of conducting an electric current if the ignition system became short-circuited. No protective device or spring cap was used on the gasoline tank, and therefore there was danger of gasoline fumes or gasoline escaping from the tank falling on the hot exhaust pipe and igniting. There was no protective wire gauze or flame baffle on the exhaust pipe, to prevent a backfire flame from igniting the explosives, oil, or gasoline. The bottom of the truck was not protected by asbestos or other heat absorbing material and the wiring of the electrical system was by no means rugged. Moreover, several different kinds of explosives were loaded on the same truck, and the kegs of black blasting powder, instead of being placed on their sides and staggered, were placed in tiers and set on end, thereby making it possible for the bungs to be opened by the movement of the chime of an adjacent keg.

The fire burned most of the inflammable parts of the truck, and hence much of the evidence was destroyed so that the exact cause of the detonation and fire could not be determined definitely. There were several possible sources of ignition; if the driver was smoking, gasoline from the tank, located under the driver's seat, or explosive in the truck may have been ignited. Although the man was in the habit of smoking occasionally, his employer believed him too careful to have smoked in the truck while transporting explosives; only too frequently persons who transport or handle explosives persist in smoking while so doing.

The end of the exhaust pipe was about under the center of the cab, was not within less than 4 inches of the wooden flooring of the truck, and was not within 4 feet of the load. As the truck was traveling upgrade at the time of the explosion, the chances of back-firing were remote; however, there is a possibility that sparks from the engine were carried to the load by wind.

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The gasoline tank, gasoline line, carburetor, and vacuum feed tank were said to have been inspected and found to be in good condition on the day the truck started on the trip; however, the cap to the gasoline tank could not be located after the fire. As this was the only opening found in the tank, it is possible that the cap had not been properly replaced upon filling the tank during the trip and that the gasoline or gasoline fumes may have come in contact with the hot exhaust pipe and ignited or exploded.

The accident occurred during daylight, and the lighting switch was in the "off" position; nevertheless it would be possible for a short circuit to take place in one of the lead wires from the generator or the battery to some metal part. An electric spark may then have been carried through the sheet steel in front of the body to the black blasting powder.

No moisture had fallen in the region for several weeks, and the air temperature was between 90 and 100° at the time of the accident. Under these conditions it would be possible for a spark of static electricity to have been formed. Such a spark would be capable of igniting the explosives.

The black blasting powder was in kegs constructed of No. 28 gage sheet steel, mechanically crimped together at the joints. The opening in the top of each keg was sealed by means of a cardboard gasket and a metal plug, held in place by a metal slide gate. Each keg had been immersed in heavy asphaltum paint, tending to prevent leakage from the can and to protect against sparks induced by friction. There is no question that some fine particles of black blasting powder escaped from one or more of the cans and then were ignited by at least one of the above enumerated causes.

The manufacturers of explosives have recognized the necessity of transporting explosives by automobile trucks and they have given close attention to the safety of their drivers by providing definite rules for safeguarding the truck. The Hercules Powder Co. issues the following standard truck specifications for hauling explosives:

HERCULES STANDARD TRUCK SPECIFICATIONS
FOR HAULING EXPLOSIVES

"Motor vehicles used for hauling explosives at various magazine distributing points must comply with the following specifications:

(1) Covering consisting of ¼" asbestos and No. 20 gauge sheet iron should be placed on underside of the box, under the gasoline tank, under the foot boards and up the front end of the box between the box and the cab. If the dash board is not metal, it should also be applied to the dash board.

(2) A metal shield should be placed under the gasoline tank and over the exhaust pipes so that any leaking gasoline will shed off and not drop on the hot exhaust pipes.

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(3) The cab should be equipped with two fire extinguishers. It would also be well to have convenient containers filled with dry sand in a convenient place, for this is one of the best agents for putting out fires around motor vehicles.

(4) All nails and bolts on the inside of the box should be blind or countersunk and plugged, so that no sparking metal is exposed. Nothing but some non-sparking metal such as brass should be exposed on the inside of the box or used to bind the top of the box or tail-gate.

(5) The shut-off valve in the gasoline line near the gasoline tank should be equipped with an extension with knob on the end, at a convenient point near the driver's seat so that the driver can shut off the gasoline at the gasoline tank without taking up the floor boards.

(6) The pan under the engine should have a slit in the bottom of it about $\frac{3}{4}$" wide and extending practically the full length of the pan. Metal is left in place at two or three points, merely to hold the two halves together. This slit should allow all gasoline and oil that may drop into the pan to drain out and not accumulate in the pan for such an inflammable accumulation is a bad fire hazard. In addition, special precautions should be taken in operating the truck to see that the engine, pan and other parts of the truck are kept free from accumulations of gasoline, oil, grease and other inflammable material.

(7) Only electric lights should be used and should consist of two headlights, two side lights and a tail light. If convenient, the tail light should be put in series with a dash light as an indicator. A good high tension generator and an approved type of storage battery should be used. The generator should not be relied upon alone for lights, for in case of engine trouble, lights would not be available. No part of the electric system should be grounded to the truck frame or body, but instead all wires should be double run in armor steel conduits only, the two wire system being used. The lighting system should not include a portable light or spotlight.

(8) A heavy tarpaulin should be used, and a loaded truck should at all times be covered with it.

(9) Truck should be equipped with such accessories as mirror, horn, bumpers, speedometer, etc.

(10) On each side of the body and on the tail-gate, in letters 6" high should appear.

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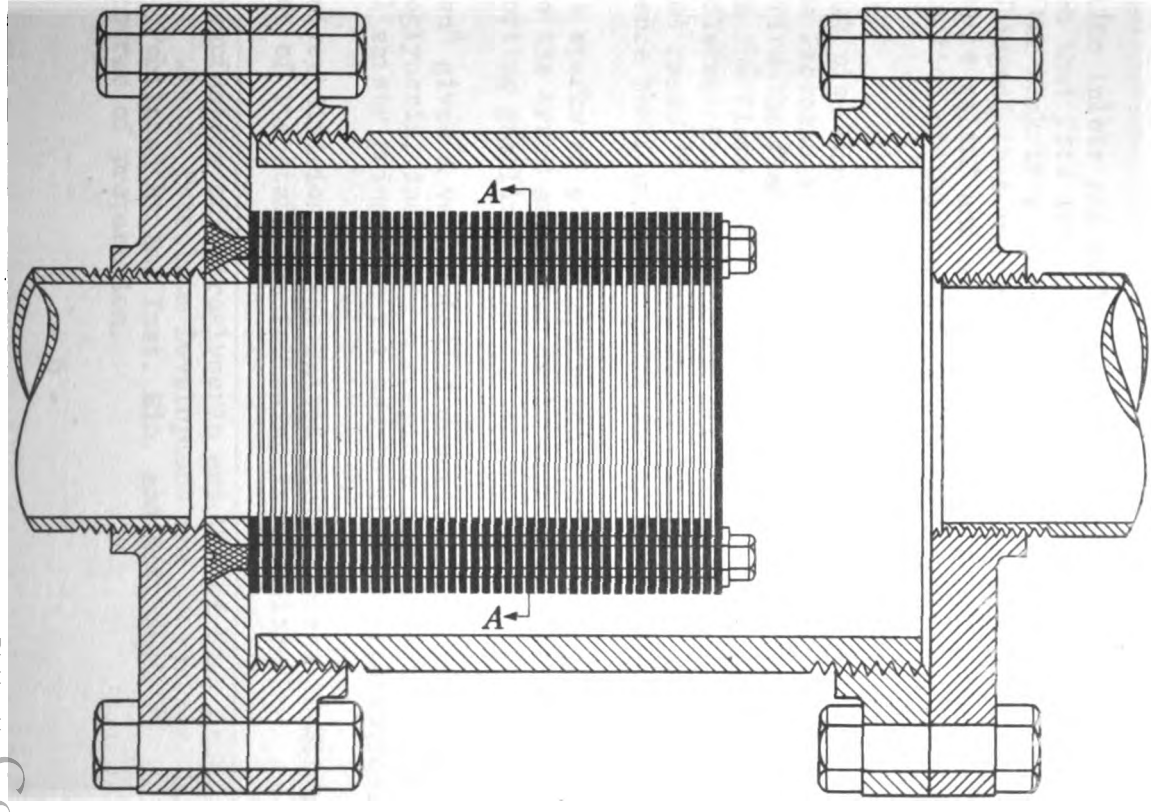
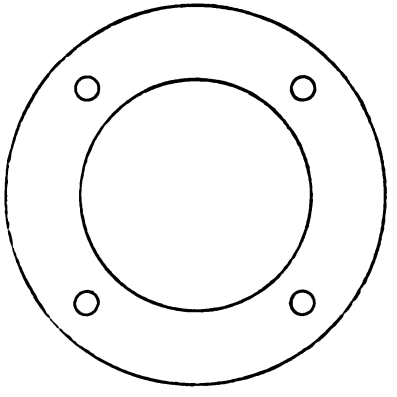


Figure 1. – Disk flame baffle



SECTION A–A

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The color usually recommended for the body is a vermillion red with letters in a contrasting color such as aluminum color. The figure of Hercules should also appear on each side of the body, and for this purpose decalcomanias of suitable size can be furnished from the home office.

(11) All gasoline tank inlets and outlets should be equipped with Protectoseals.

(12) The exhaust pipe should be equipped with a flame baffle fitted to the end of the pipe. This flame baffle can be made of 40 mesh wire screen cloth having a net sectional area equal to the diameter of the exhaust pipe."

The gasoline inlets and outlets are protected by a device consisting of a combination screen that fits into the tank, thereby preventing communication of flame outside of the tank if a spark ignites the fluid in the tank, and a cap, generally spring-hinged, that prevents evaporation of the gasoline and provides an automatic pressure relief and a vacuum breaker, by allowing air to intake into the tank. A protection of this nature should be provided on all trucks hauling explosives.

The exhaust pipe should be protected by a flame baffle. A disk flame baffle made by the Protectoseal Co. is shown in the accompanying illustration. In case of a backfire the flame would enter the series of disks. The outermost disk is solid, and the flame and hot gases must therefore pass through the openings between the disks. The openings are made according to a definite ratio with the disks. The hot gases in passing through the openings are cooled below ignition point, and hence the flame does not pass out of the baffle.

To prevent sparks of static electricity from forming, it is advisable to connect a chain to the truck and allow it to drag on the ground as is required for trucks transporting gasoline.

C. O. Rison[4] gives a very detailed description of the method of transportation of nitroglycerin, including a complete description of a motor truck which embodies all safety principles for use in this transportation.

The explosives division of the United States Bureau of Mines has prepared for the information of its staff the following instructions:[5]

4 Rison, C. O., Manufacture of Nitroglycerin and Use of High Explosives in Oil and Gas Wells: Trans. Petroleum Development and Technology, 1928-29, pp. 256-259. Published by Am. Inst. Min. and Met. Eng.

5 Manuscript in course of preparation.

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Hauling Explosives

Explosives may be hauled by motor vehicles.

When used in hauling explosives the vehicle must be placarded "High Explosives - Dangerous" and it must conform with any other regulations, laws, or ordinances of the Interstate Commerce Commission and of the States, municipalities, and communities through which it is to pass.

Before explosives are loaded into a vehicle the body of the vehicle should be thoroughly swept.

Vehicles must always be kept in first class repair.

Boxes of explosives must be so arranged and stayed in the body of the vehicles that they cannot shift during transportation.

The containers of explosives must be protected from exposure to the sun's rays, rain, snow, etc. They should rest upon and be covered by a canvas or tarpaulin. Preferably they should be placed and locked in a large covered box or compartment; the inside surfaces should be wholly of wood. The box or compartment must be located as far as possible from the engine and effectively insulated from it and from all sources of electricity. The engine exhaust must be pointed downward.

No detonators or electric detonators should be hauled with explosives, except when going to make a demonstration; to fire a blast; or in the collection of field samples, and then the detonators or electric detonators must be placed in such a receptacle and at so remote a distance from the explosives in the vehicle that the explosion of the detonators, or electric detonators, could not induce the explosion of the explosives through the intervening barricades. In order to prevent any accumulation of static electrical charges on the truck a metallic chain sufficiently long so that at least four inches of its end will drag upon the ground should be attached to the rear end of the truck, or motor vehicle.

No metallic objects, such as tools and machinery, or heavy masses should be hauled in the same vehicle with explosives, or with detonators, or electric detonators.

No vehicle containing explosives shall be left until the motor has been stopped and the brakes set. Safe practice requires that there should always be a guard on a vehicle containing explosives.

During haulage of explosives avoid as much as possible congested thoroughfares, places where crowds are assembled, street car tracks, and dangerous crossings.

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Rules for transporting explosives, as recommended by the Institute of Makers of Explosives, follow:

In transporting explosives avoid all unnecessary stops. Do not haul through cities, towns or villages when possible to avoid it, but where this is necessary keep off congested thoroughfares, street car tracks and dangerous crossings. Vehicles transporting explosives must come to a full stop before crossing any railroad track, and must not cross it until it is known the way is clear and no train or engine is approaching.

Do not leave any vehicle containing explosives unless team is securely tied and brakes set, or if motor truck is used, motor should be stopped and brakes set.

Do not carry blasting caps or electric blasting caps in the bed or body of vehicle containing other explosives.

Do not carry metal, metal tools or inflammable substances in the bed or body of vehicles transporting explosives.

The vehicle used for transporting explosives should have a close, tight floor. If there is any exposed metal on the inside of the body, it should be covered or protected so that the explosives containers will not come in contact with the exposed metal. Trucks used for the transportation of explosives should be clean, and free from surplus oil and grease, wiring completely insulated, gasoline and exhaust lines free from leaks, and the necessary precautions taken to prevent truck fires.

When explosives are on vehicles without tops they should always be protected from sun and weather by a tarpaulin.

Vehicles and harness used for transporting explosives should always be kept in first-class repair. Do not run any risk of vehicles or harness breaking down.

The necessity for keeping vehicles in first-class repair is shown in the account of a recent accident while a truck was transporting explosives.

An automobile truck and trailer were used to transport 100 cases of 60 per cent gelatin dynamite and 270 kegs of black blasting powder over a main highway. Part of the trip was up a steep grade. The truck was of the chain-drive type with the foot brake operating on the sprocket wheel that drove the chain. The trailer was without brakes.

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While driving up the steep grade the drive chain broke, rendering the foot brake useless, and the emergency brake failed to hold. The truck ran backwards into the trailer and caused the loads on the truck and trailer to be dumped into the highway. Several cases of gelatin dynamite were broken open and 113 kegs of black blasting powder were spilled. Seven of the kegs broke open spilling considerable black powder on the concrete road. Some of the kegs were dragged along the concrete and evidently sparks must have been given off, but fortunately the explosives were not ignited.

This accident shows the necessity for careful inspection of all vehicles before they are used to transport explosives. No truck should be allowed to carry explosives unless the truck is in safe working condition, especially as to brakes and as to protection of the explosive from heat or sparks from the engine of the truck.

In transporting explosives, railroads should be used whenever possible, especially when the haul is for any considerable distance; and in general, the old-fashioned mode of horse and wagon hauling is as yet the safest way to carry the explosive from the railroad to the storage magazine, and from the storage magazine to the distributing point at a safe distance from the mine opening. If trucks are used, the precautions recommended above or others equally effective should be taken to prevent explosions during surface transportation of explosives.

ACKNOWLEDGMENT

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